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A Report Submitted To The

Fifty-fifth Montana Legislature

by

Governor Marc Racicot

pursuant to
Montana Code Annotated, Sec. 85-1-704 (1991)

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TABLE OF CONTENTS

ABSTRACT iv

MONTANA WATER PROJECTS MAP v

TABLE 1. PROJECT SUMMARY vi

I. INTRODUCTION 1

II. WATER STORAGE POLICY AND STATUTORY CRITERIA 1

WATER STORAGE PROJECT PRIORITIZATION POLICY 2

WATER STORAGE PROJECTS PRIORITIZED 3

JUSTIFICATION FOR PROJECT PRIORITIZATION 3

III. WATER STORAGE PROJECT CLASSIFICATION AND TERMINOLOGY . . . 6

IV. WATER PROJECTS SUMMARIZED 7

REHABILITATION AND REPAIR PROJECTS 7

TONGUE RIVER DAM REHABILITATION 7

DEADMAN'S BASIN WATER QUALITY IMPROVEMENT PROJECT 10

PETROLIA DAM REHABILITATION 12

BEARPAW LAKE DAM REHABILITATION 14

NORTH FORK SMITH RIVER DAM REHABILITATION 16

LOWER BAKER LAKE SPILLWAY REHABILITATION 18

LAKE FRANCES EAST DAM REHABILITATION 20

LONE TREE DAM REHABILITATION STUDY 22

TIN CUP LAKE DAM REHABILITATION 24

MALTA IRRIGATION DISTRICT
CANAL EFFICIENCY IMPROVEMENT 26

BASS LAKE DAM REHABILITATION 28

CANYON CREEK DAM REPAIR 30

DELMOE LAKE DAM 31

EAST FORK OF ROCK CREEK DAM REPAIR
AND REHABILITATION 32

WILLOW CREEK DAM REPAIR 35

COMO LAKE DAM REPAIR AND REHABILITATION 37

NEW STORAGE PROJECTS 39

RUBY CREEK WATER STORAGE STUDY 39

CHERRY CREEK RESERVOIR STUDY 43

V. SEEPAGE MONITORING FOR HIGH-HAZARD DAMS 44

ABSTRACT

The Governor is required by statute to submit a report on water storage to the Montana Legislature each regular session. The *Governor's Report on Water Storage in Montana* reviews state water storage policy and statutory criteria used to prioritize projects, identifies projects proposed for development, and summarizes water storage rehabilitation projects in progress during the previous two years. Project summaries provide information on background, financing, current status, and implementation strategy. The report also includes a table summarizing the projects, and a map indicating project type and location.

A dam can be determined to be *unsafe* if its spillway is unable to withstand and route a certain percentage of a probable maximum flood, or if its structural integrity has become compromised since construction, and is in need of rehabilitation. All dams under rehabilitation in 1995-96 were, at one time, determined to be *unsafe*. A dam is classified as *high-hazard* if its failure has the potential for loss of human life. All existing storage projects addressed in the *Governor's Report* are classified *high hazard*. *Repair* of a project allows it to function as originally designed. *Rehabilitation* involves upgrading existing projects to comply with or exceed current design standards and often includes repair work.

The rehabilitation of the Tongue River Dam is the state's top priority, requiring *all* funds currently available in the Water Storage Special Revenue Account. Completion of the Tongue River Dam project is projected for 1999. The state's other priority project, the Deadmans's Basin Water Quality Improvement Project, is projected for completion by December 1997. The rehabilitation of Como Dam, owned by the Bitterroot Irrigation Company, was completed in 1995. Rehabilitation of Bearpaw Dam and Petrolia Dam, state-owned projects ranked second and third in 1995, were completed in 1995 and 1996, respectively. Three private dams, Bass Lake, Delmoe Lake, and Lake Frances, and a county dam, Baker Lake, were rehabilitated in 1996.

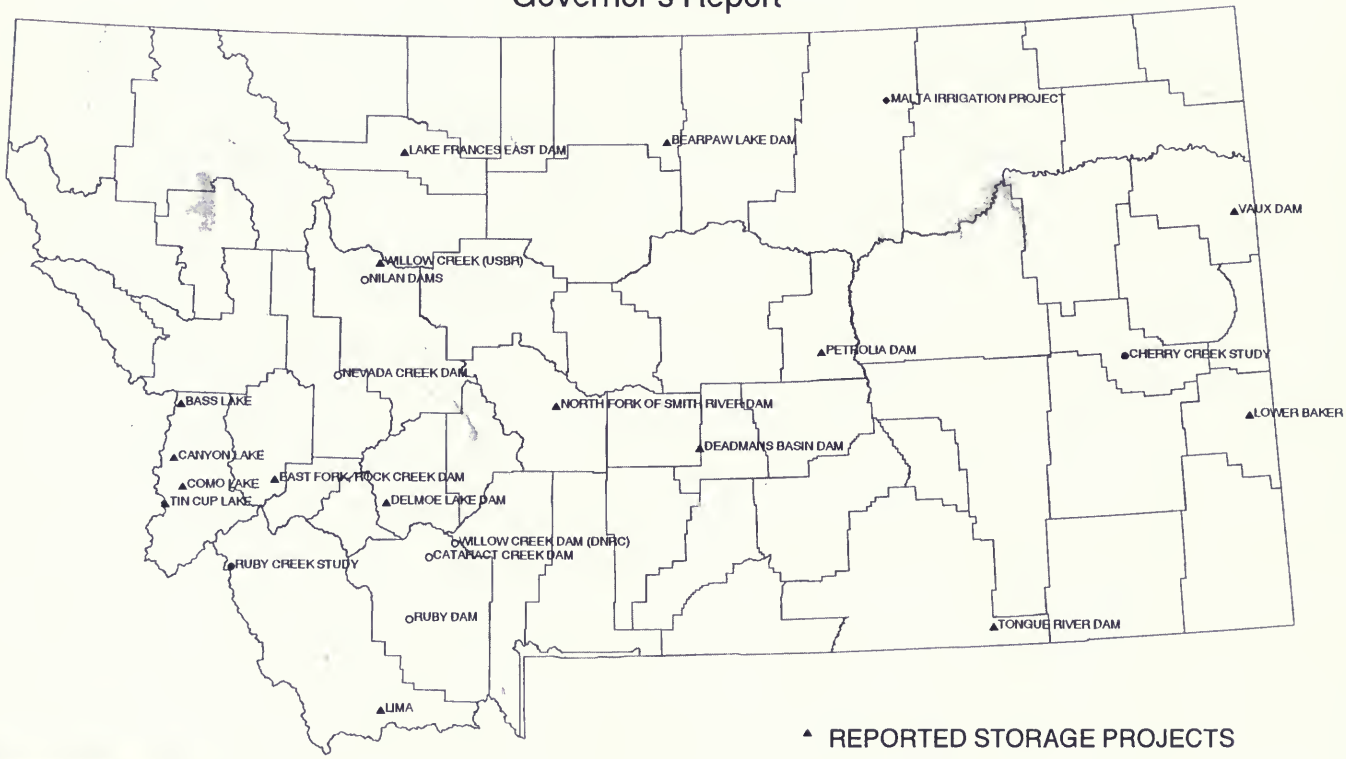
There were three emergency dam repair projects in 1996, all completed before the end of the 1996 construction season: Canyon Creek (irrigation district), East Fork of Rock Creek (DNRC), and Willow Creek (U.S. Bureau of Reclamation). The Malta Irrigation District Canal Improvement project was also completed in 1996. The rehabilitation of North Fork of Smith River Dam, ranked fourth among state-owned priorities in 1995, has been on hold pending the completion of the *Extreme Storm Event Study* by DNRC and the U.S. Geological Survey in spring of 1997. The study, funded by the 1993 Legislature, is expected to relax dam spillway design standards on dams regulated by the state and ultimately, reduce the cost of future dam rehabilitation projects.

The Ruby Creek storage study, classified as "new" in the 1995 storage report remains in the pre-feasibility study stage for this biennium and the Cherry Creek project, which was in the planning stage in 1994, is now inactive and cannot proceed without a new source of funding.

MONTANA WATER STORAGE PROJECTS

1997

Governor's Report



▲ REPORTED STORAGE PROJECTS

● STORAGE STUDY PROJECT

◆ CANAL EFFICIENCY PROJECT

○ DAM SEEPAGE MONITORING PROGRAM

MONTANA DNRC

Table 1.
GOVERNOR'S REPORT ON WATER STORAGE 1997
(alphabetically arranged)

Name/Use	County/Owner	Background	Plan	Cost*	Status	Complete
Lower Baker Lake Dam Rehabilitation/Recreation	Fallon/Fallon County	Built-1914 Unsafe-1979	Replace spillway	$64K G - $31,743 1995	Underway	Dec. 1996
Bass Lake Dam Rehabilitation Irrigation	Ravalli/ Bass Lake Res. Company	Built-1952 Wilderness Unsafe	Replace outlet & widen spillway	$280K	Completed	Oct. 1996
Bearpaw Lake Dam Rehabilitation/Recreation	Hill/MT Fish, Wildlife, Parks	Built-1958 Unsafe 1989	Repair spillway and Dam	$375K (estimate)	Completed	Aug. 1995
Canyon Creek Dam Repair/Irrigation	Ravalli/Canyon Creek Res. Co.	Built-1891 Damage-'96	Replace lost dam earthfill	$59K	Completed	Oct. 1996
Cherry Creek Reservoir Study Proposal /Rec.	Prairie/Town of Terry	BLM Feasibility Study-'89-93	Write EIS	NA	Inactive - lack of funding	N/A
Como Lake Dam Rehabilitation Irrigation/Recreation	Ravalli/ Bitterroot Irrigation Company	Built-1910 Unsafe-1984	Rehabilitate dam and increase storage	$3 M	Completed	May 1995
Deadman's Basin Water Quality Project/Irrigation	Wheatland/Golden Valley/Water Users Association	Built 1934-40 Sedimentation problems	Re-routing of water - canal enlargement	$192K L - $111,081 G - $47,919	One phase remains in 1977	Dec. 1997 (Est.)
Delmoe Lake Dam Rehabilitation/Irrigation	Jefferson/Pipestone Water Users Assoc.	Built 1914 Seepage-1994	Repair drainage system & toe berm	$25K	Complete	August 1996
Lake Frances East Dam Rehab./Irrig., Municipal	Pondera/Pondera Canal & Res. Co.	Built 1913 Unsafe 1980	Replace intake pipe & controls	$600K G - $50K	Nearly complete	Nov. 1996

Name/Use	County/Owner	Background	Plan	Cost*	Status	Complete
Lone Tree Dam Rehab. Study (Vaux 11 Dam) Irrigation/Flood	Richland/Lone Tree Ranch, Inc.	Built 1944 Failed 1951 Unsafe 1978	Enlarge spillway	$400K (est.) $100K Grant requested 1996-1997	Res. Empty Unable to Fund proj.	N/A
Malta Irrigation District Canal Improvement./Irrig.	Phillips Malta Irrig. Dist.	Built 1909-23 Irr. Control Icing	Efficiency- add new control structures	$498K G - $50,000 1993	Nearly complete	Nov. 1996 (Est.)
Petrolia Dam Rehabilitation/Irrigation	Petroleum State-owned	Built 1951 Unsafe 1980	Replace spillways, control seepage	$1.4M L - $358K	Completed	Nov. 1996
E. Fk. Rock Creek Dam Repair-Rehab./Irrigation	Granite State-owned	Built 1930 Sinkhole 6/96	Repair dam & outlet work.	$1.5M G - $370K	Nearly complete	Dec. 1996 (Estimated)
Ruby Creek Water Storage Study Irrigation/Fishery	Beaverhead Ruby Water Co.	SGS Study-1968	1996-97 Pre-feasibility study	$1.2M (est) G - $14,708 1991	Pre-feasibility Cost Analysis	N/A
Tin Cup Lake Dam Rehabilitation Irrigation	Ravalli Tin Cup Water Users Assoc.	Built 1906 Unsafe 1980 (spillway)	Dam core; Spillway repair & and mod.	$304K L - $304,204 1993	Plan pending study	1997 outlet rpr. remainder uncertain
Tongue River Dam Rehabilitation Irrigation / recreation	Big Horn State-owned	Built 1937-39; spillway flood damage 1978	Increase cap.; new spillways, recreation fac.	$63.4M Federal $16.5M State	EIS final; construction underway	1999 (Estimated)
Willow Creek Dam Repair /Irrigation	Lewis and Clark U.S. Bureau of Reclamation	Built 1911 Mod. 1917,41 Sinkholes'58'96	Dam embankment & outlet repair	$1.6M	Nearly complete	Dec. 1996
N. Fk. Smith River Dam Rehabilitation/Irrigation	Meagher State-owned	Built 1936 Unsafe 1980	Studies underway	L - $1,035,467	Plan pending Study findings	N/A

* First figure is total project cost; cost estimates are rounded up; see project summaries for exact figures.
G - Grant Renewable Resource Grant and Loan Program
L - Loan Renewable Resource Grant and Loan Program

I. INTRODUCTION

The Governor is required by statute to submit a report on water storage to the legislature each regular session. The *Governor's Report on Water Storage in Montana* : reviews state water storage policy and statutory criteria used for prioritization of proposed projects; identifies water storage projects proposed for development, including the rehabilitation of existing projects and progress on new projects; and summarizes water storage projects in progress during the previous two years. Project summaries provide information on background, status, and implementation strategy. The report includes a table summarizing the projects and a map indicating each project type and its location.

II. WATER STORAGE POLICY AND STATUTORY CRITERIA

The 1991 Montana Legislature passed into law a policy on water storage to define when storage is the best solution for solving specific water problems. When storage is determined to be the best alternative, the policy identifies criteria to use in ranking state-funded projects (Sections 85-1-701 through 704 MCA). This law is based on the water storage section of the state water plan, developed over a two-year period by three technical committees and the State Water Plan Advisory Council, with participation and guidance from the Governor's Office and the Legislative Water Policy Committee. Montana's water storage policy is as follows:

> The legislature recognizes that water resources needs are growing, existing water facilities are aging and in need of repair, and new water storage projects have become more difficult to complete. Other types of actions will be needed to solve many emerging problems, but if storage is the best way to meet growing water needs and solve problems, it should be actively pursued.

In determining the best solution for a particular water management problem, the state shall:

a. carefully define the problem;
b. identify all options to solve the problem, including water storage;
c. determine whether water is physically and legally available to solve the problem; and
d. select the option that best meets the following criteria:
    i. technical feasibility
    ii. financial feasibility
    iii. economic feasibility
    iv. political feasibility
    v. legal feasibility, and
    vi. environmental feasibility

WATER STORAGE PROJECT PRIORITIZATION POLICY

The statute calls for this report to the legislature and describes its requirements. The statute also identifies different criteria to be used to prioritize new water storage projects, storage rehabilitation projects, and budget priorities for the allocation of state water storage development funds. Section **85-1-704 Prioritization of water storage projects - governor's report**, states:

(1) The governor shall submit to each regular session of the legislature a report identifying specific water storage projects proposed for development, including the rehabilitation of existing projects and new project proposals. The report must contain:

a) a list of water storage project priorities;

b) an implementation strategy for each priority project that identifies the resources (including specific budget requests), government actions, and other actions needed to accomplish the project; and

c) a progress report on the development of water storage projects during the previous 2 years.

(2) In setting priorities among new water storage projects, the governor shall consider whether a project:

a) solves a severe water problem;

b) provides multiple uses and benefits;

c) provides for public uses;

d) shows strong evidence of broad citizen support;

e) is able to obtain non-state sources of funding;

f) protects and seeks to enhance social, ecological, cultural, aesthetic values;

g) improves local and state economic development;

h) could resolve Indian and federal reserved water rights issues;

I) supports water conservation activities; and

j) promotes the use of water reserved under Montana law.

(3) In setting priorities among water storage rehabilitation projects, the governor shall consider whether the project:

a) is needed to protect public safety;

b) has impacts if not repaired or rehabilitated; and

c) accomplishes the goals listed in subsection (2)(a) through (2)(j).

(4) In establishing budget priorities for the allocation of state water storage development funds:

a) First preference must be given to projects that resolve threats to life and property posed by high-hazard facilities that are in an unsafe condition;

b) Second preference must be given to projects that improve or expand existing water storage facilities; and

c) Third preference must be given to the planning and construction of new water storage facilities.

WATER STORAGE PROJECTS PRIORITIZED

The following projects are prioritized using the criteria in Sec. 85-1-704 (4) MCA.

State-owned Rehabilitation Projects

1. TONGUE RIVER DAM REHABILITATION
2. DEADMAN'S BASIN WATER QUALITY IMPROVEMENT PROJECT

State-owned Emergency Repair Project

1. EAST FORK ROCK CREEK DAM REPAIR AND REHABILITATION

Rehabilitation Projects, Not State-owned

1. TIN CUP LAKE DAM REHABILITATION

New Project

1. RUBY CREEK WATER STORAGE STUDY

JUSTIFICATION FOR PROJECT PRIORITIZATION

The following rehabilitation projects are prioritized by DNRC according to the criteria identified by Montana Code Annotated (MCA) listed at the beginning of this report.

State-owned Rehabilitation Projects

1) Tongue River Dam Rehabilitation

This project has been the state's highest water storage priority since 1990. A moderate flood in 1978 caused $1,000,000 damage to the spillway and demonstrated the potential for disaster on a larger scale. The dam is classified *high-hazard* because its failure could jeopardize 7,000 human lives. The dam was also found to be *unsafe* due to an inadequate spillway. The dam's rehabilitation will contribute to the settlement of the federally reserved water rights of the Northern Cheyenne Tribe. In 1995, $3.5 million in state funding was budgeted for the Tongue River Dam rehabilitation project. Approximately $32 million in federal funds has also been appropriated for construction of the Tongue Dam project. The project meets the first and second priority criteria: it resolves threats to life and property posed by a high-hazard facility in unsafe condition; and improves or expands an existing storage facility.

2) Deadman's Basin Water Quality Improvement Project

Deadman's Basin Reservoir is owned by DNRC and operated and maintained by the Deadman's Basin Water Users Association (DBWUA). Water is released from the project through two canals: the Careless Creek Canal and the Barber Canal. The proposed rehabilitation project will increase the capacity of the Barber Canal from 200 to 300 cubic feet per second (cfs). This will allow a decrease in flow in Careless Creek and the canal from 250 to 150 cfs, which will enable the project to meet water quality standards in Careless Creek. The EPA has apprised DBWUA that these standards are routinely violated in Careless Creek by erosion caused by the 250 cfs flow. DNRC received a loan from the Renewable Resource Grant and Loan (RRGL) program of $111,000 and grant of $47,919 to enlarge Barber Canal and to develop a rehabilitation plan for the existing concrete structures in the Barber Canal. Total project cost is $191,594. DBWUA will contribute $32,675. State water project prioritization policy gives second preference to projects that improve or expand existing facilities. Completion of the project is expected in December 1997.

State-owned Emergency Project

1) East Fork Rock Creek Repair and Rehabilitation Project

East Fork of Rock Creek Dam is located about 30 miles west of Anaconda. Built in 1937-38, East Fork Dam is owned by the state, managed by DNRC, and used primarily as a water supply for the Flint Creek Water Users Association. On June 29, 1996, muddy water was discovered flowing from a drainage pipe in the main embankment of the Dam. On July 4, turbidity increased significantly and a sinkhole appeared on the downstream face of the dam, directly above the main drain pipe. The East Fork Valley residents were evacuated soon after.

The East Fork Dam repair and rehabilitation project has been underway for four months. Monitoring and relief wells are being drilled and new drain pipe is being installed. The area surrounding the main drain pipe has been excavated to allow the removal of the corroded metal pipe and the laying of the new pipe. Fill material is being hauled to the reservoir's west bank where it is sorted for desired size and purpose. The total cost of the repairs and rehabilitation is estimated to be approximately $1.5 million. The state will contribute $370,000 and the Flint Creek Water Users will pay the remainder through the sale of $1 million in bonds with a 20-year term. The project meets the first and second priority criteria: it resolves threats to life and property posed by a high-hazard facility in unsafe condition; and improves or expands an existing storage facility.

Rehabilitation Projects Not Owned by State

1) Tin Cup Lake Dam Rehabilitation

A $302,204 RRGL loan was approved by the 1993 Legislature for the dam's rehabilitation. The dam was found to be *unsafe* and is classified as *high-hazard* due to the potential for loss of life in the event of failure. The dam is owned and operated by the Tin Cup Water Users Company. The dam is located entirely within the boundaries of the Selway-Bitterroot Wilderness Area and supplies water to 1,300 acres of farmland in the Bitterroot Valley. The Tin Cup Water Company is in the process of becoming a public entity to qualify for use of their approved loan.

New Project

1) Ruby Creek Water Storage Study

The proposed reservoir site is located on Ruby Creek 10 miles west of Wisdom. The proposed dam would measure approximately 60 feet in height, 2100 feet in length, and would impound about 4,000 acre-feet of water. The applicant is the Ruby Water Company of Wisdom. The project would provide irrigation water to 1000 acres, and may provide protection of spawning habitat for the last native riverine arctic grayling population in the lower forty-eight states. A pre-feasibility analysis will be prepared by DNRC in 1997.

Water Storage Special Revenue Account

Dams classified as high hazard that are in unsafe condition receive first preference for use of funds from the state's Water Storage Special Revenue Account (Section 85-1-631 MCA). This account was designated by the 1991 Legislature to allocate 25 percent of the grant funds available, or $500,000 each biennium, under the Renewable Resource Grant and Loan (RRGL) program. The funds are to be used exclusively for water storage projects. As the state's top priority, the rehabilitation of the Tongue River Dam will require *all* funds currently available in the Water Storage Special Revenue Account, with one exception. In 1996, $102,760 in interest from the special storage account was used on an emergency basis to cover expenses incurred for the repair of East Fork Rock Creek Dam.

Renewable Resource Grant and Loan Program

The RRGL program has its own set of criteria for the ranking of project proposals. Grant applications for water-related proposals receive a high priority. The RRGL program supports projects which promote water storage priorities established in the State Water Plan.

III. WATER STORAGE PROJECT CLASSIFICATION AND TERMINOLOGY

It is important that the reader have a basic understanding of some principles and terms related to dam safety and classification used in this report. In the early 1980's the Army Corps of Engineers inspected the state's dams. The Corps declared a dam *unsafe* if its spillway would be unable to withstand and route 50 percent of a probable maximum flood (PMF), which is determined by the dam site's particular risk characteristics. A PMF is the flood that would result from a combination of extreme meteorological (storm) and hydrological conditions. An Extreme Storm Event Study, now in progress, may result in changes to dam design standards and thresholds for the *unsafe* designation. A dam can also be found to be *unsafe* if its structural integrity has become compromised since construction due to age or other external factors, and is in need of repair. All Montana dams rehabilitated in 1995-96 were previously declared to be unsafe, with the exception of East Fork of Rock Creek.

A dam is classified as *high-hazard* if its failure has the potential for loss of human life and property damage. All storage projects addressed in the *Governor's Report* are classified as *high hazard* and will remain classified as *high hazard* following the completion of proposed work. The state's highest priority for repair and rehabilitation is assigned to dams classified as *high-hazard* that are also *unsafe*. The "high-hazard" classification should not be confused with assessments of a dam's structural integrity or condition.

Repair of a project allows it to function as originally designed. Design standards have evolved considerably since the construction of most of the state's dams and repair alone may not bring a facility up to current design standards. *Rehabilitation* involves upgrading existing projects to comply with or exceed current design standards and often includes repair work. The storage capacity of a project is sometimes increased during rehabilitation, especially if enlargement is determined to be a cost-effective alternative.

Extreme Storm Event Study

The *Extreme Storm Event Study,* being conducted by DNRC and the U.S. Geological Survey, was funded by the 1993 Legislature with a $100,000 Renewable Resource Grant, and matched with funding by the USGS. The study is expected to relax dam spillway design standards and ultimately, reduce the cost of future dam rehabilitation projects. For example, a dam with a spillway once found to be unsafe, may be determined to be safe with less extensive rehabilitation than required previous to the study. The USGS has completed the first phase of the study, a regional analysis of extreme storm events, and is currently conducting the second phase, defining the temporal and spatial characteristics of such events. The report is expected to be completed in spring of 1997.

IV. WATER PROJECTS SUMMARIZED

This section describes each repair and rehabilitation project and water storage proposal in detail. Project descriptions include information on funding, background, current status, and implementation strategy. A number of rehabilitation projects started during the last biennium were completed in 1995-96, and several more are ongoing. One rehabilitation project being planned during the last biennium is in a "hold" status pending the findings of an extreme storm event study that may have a bearing on future dam spillway design requirements. No new rehabilitation projects are proposed at the present time.

There were three emergency repair projects in 1996, all of which were completed before the conclusion of the 1996 construction season. One proposed project classified as "new" in the 1995 water storage report remains in the pre-feasibility study stage for this biennium and the other new project, in the planning stage in 1994, is now inactive and cannot proceed without a new source of funding

REHABILITATION AND REPAIR PROJECTS

This section contains current information concerning projects that were in progress when reported in the 1995 Governors report on water storage, or were started during the past two years. Some projects have been completed during the last two years, while work on others will continue into the next biennium. Three emergency dam repair projects, all occurring and completed in 1996, are reported as well.

TONGUE RIVER DAM REHABILITATION

The Tongue River Dam is located in southeastern Montana 10 miles north of the point where the Tongue River flows into Montana from Wyoming. The Tongue River carves a 265 mile-long valley from its headwaters in Wyoming's Bighorn Mountains to its confluence with the Yellowstone River at Miles City, Montana.

Description

The existing dam embankment is 91 feet high and 1,824 feet long, with a crest width of 55 feet. The reservoir has a surface area of 3,200 acres, a usable capacity of 66,640 acre-feet (af) of water, and average storage of 48,210 af. The reinforced concrete spillway is 350 feet wide at its crest and 100 feet wide at its base. The maximum discharge capacity of the outlet works is approximately 4,000 cubic feet per second (cfs). The reservoir measures approximately 8 miles in length and averages one-half mile in width.

As an interstate river, the Tongue River is subject to the terms of The Yellowstone River Compact between Montana, North Dakota, and Wyoming. The Tongue River project provides a reliable supply of water for the irrigation of 15,000 acres of land between the dam and Miles City. Nearly all the water used for irrigation supports alfalfa, feed barley, and pasture for the livestock industry. Water under contract from the project includes 39,300 af for irrigation and 7,500 af dedicated for use by the Northern Cheyenne Tribe. The state fish hatchery in Miles City has contracted for 650 af and the St. Labre Mission in Ashland has contracted for 50 af of water for a total of 40,000 af of contracted water.

Background

The dam developed structural problems during a moderate flood in May 1978, when water being spilled severely eroded areas behind each of the wingwalls at the spillway's lower end. This damage took place during a spillway flow of 6,800 cfs. The spillway originally was designed to accommodate a flow of 62,500 cfs. The reservoir was full as recently as mid-July 1992, due to abundant summer rains. Under such conditions, a significant precipitation event easily could create a hazardous situation for the dam and the downstream population.

A Corps of Engineers dam inspection resulted in the Tongue River Dam's classification as a *high-hazard* dam. The Corps further determined that the dam was *unsafe*, due to the inability of its spillway to accommodate large flows. The approximately $1 million in damage to the spillway during the flood of 1978 illustrates the deficiencies of the Tongue River Dam and underscores the magnitude of the threat posed by a large-scale flood.

An enlarged Tongue River Reservoir is critical to the settlement of the Northern Cheyenne Tribe's federal reserved water rights. A compact negotiated between the tribe and the state provides up to 20,000 additional af of water annually, to the tribe from the proposed dam rehabilitation and reservoir enlargement. It also protects the tribe's existing annual contract for 7,500 af of water. The legal settlement and the state's preferred plan call for construction of a new spillway with an additional 4 feet in crest height. Legislation to ratify the settlement and authorize federal cost-share funding for the project was passed by Congress and signed by President Bush on September 30, 1992.

The rehabilitation of the Tongue River Dam was ranked first in the *1995 Governors Report on Water Storage in Montana*. If the dam failed, the region's economy could suffer greatly from the prolonged loss of irrigation and recreation opportunities. Estimated economic costs resulting from dam failure would range from $300 to $500 million. The Northern Cheyenne Tribe would lose its 7,500 acre-feet of contracted water indefinitely. Important wildlife habitat also would be lost for a number of years. Since the flood of 1978, DNRC has operated the reservoir at reduced capacity to avoid use of the spillway.

Current Status

Federal legislation required the Secretary of the Interior to enter into a cooperative agreement for planning, design, construction, and environmental compliance on the Tongue River Dam project. That agreement was finalized on June 16, 1994. Environmental compliance for the project was completed in March of 1996, with publication of the final EIS. Currently, the reservoir is able to provide a firm annual yield of 32,000 acre-feet, although it was designed to provide an annual yield of 50,000 acre-feet.

Implementation Strategy

Construction began in late July of 1996 and is expected to be completed in 1999. The 1995 Legislature, in House Bill 5, granted continuing appropriation authority of $3,500,000 for the Tongue River Dam rehabilitation project. The $3.5 million included $1,746,000 from the Water Storage State Special Revenue Account (the entire proceeds), and $1,754,000 from the Renewable Resource Grant and Loan (RRGL) state special revenue account. It is not anticipated that the full $3.5 million will be expended in the current biennium. At this time, it is anticipated that approximately $640,000 of appropriation authority from the RRGL account will be carried forward. The state projects that it will spend approximately $16.5 million on the Tongue Dam project before completion.

Federal funding totals about $32 million for construction, mitigation, and enhancement. Costs to the federal treasury for the Tongue River Dam rehabilitation project and the settlement of the Northern Cheyenne reserved water rights will total about $63.4 million.

Summary

The rehabilitation of the Tongue River Dam was ranked first in priority in the *1995 Governors Report on Water Storage in Montana*, and is ranked first for the 1998-99 bienium. The Governor's Office and DNRC have assigned a high priority to rehabilitating and enlarging the Tongue River Dam due to its *unsafe* condition and *high-hazard* status. The repair and enlargement of the dam will eliminate the dam's current *unsafe* status resulting in a safe structure and increasing the firm annual yield.

The project offers a viable solution to several water storage issues in southeastern Montana and satisfies the storage policy objectives of the state of Montana. The Tongue River project serves to settle federal reserved water right claims of the Northern Cheyenne Tribe, supplements the supply of water in a semi-arid agricultural region, provides more opportunities for recreation, and is environmentally compatible. Finally, the project is a cost-effective solution since it increases water storage capacity and addresses a potentially hazardous situation.

DEADMAN'S BASIN WATER QUALITY IMPROVEMENT PROJECT

Deadman's Basin is a state-owned water storage and canal project located 22 miles east of Harlowton in eastern Wheatland and western Golden Valley counties.

Description

The project, operated and maintained by the Deadman's Basin Water Users Association (DBWUA), impounds 72,220 acre feet of water and irrigates approximately 26,000 acres. Deadman's Basin releases water through two outlet canals: the Careless Creek Canal and the Barber Canal. The Lower Musselshell Conservation District has determined that water quality on the lower Musselshell River can be improved by decreasing flow rates in the Careless Creek outlet canal thereby reducing erosion and sediment transported in Careless Creek.

To maintain historic flow releases from storage, the flow rate will be increased in Barber Canal to compensate for the loss in flow in Careless Creek Canal. Increased flow rate in the Barber Canal will require canal rehabilitation and enlargement. The Deadman's Basin Water Quality Improvement Project will increase the current capacity of the Barber Canal from 200 cubic feet per second (cfs) to 300 cfs and decrease flow in the Careless Creek Canal from peak discharges of 250 cfs to less than 150 cfs.

Background

The flow of Careless Creek Canal is routed through Careless Creek for about six miles before reaching the Musselshell River. Release of clear stored water into Careless Creek has resulted in considerable streambank erosion and transport of sediment downstream to the Musselshell River. This plan involves releasing a larger percentage of the water to the Musselshell River through the Barber Canal, which discharges directly to the river. Enlargement of several drop structures will be required and the canal must be stabilized to accommodate the higher flows.

The rehabilitation project is comprised of four phases. The first phase was initiated in 1993. A failed drop structure provided an opportunity for replacement with a 300 cfs structure. This phase was successfully completed through a joint effort by Golden Valley Agricultural Stabilization and Conservation Service (ASCS), DBWUA, DNRC, and the Soil Conservation Service (SCS) in December of 1993.

The second phase of the project will be the repair and enlargement of the stilling basins below existing structures and armoring of the outside bends of the Barber Canal. The third phase, now complete, was a feasibility study and design for increasing the capacity of the three existing drop structures that now limit flow capacity. The fourth, or final phase of the project is the upgrading of Barber Canal to deliver 300 cfs to the Musselshell River.

Current Status

DNRC received a RRGL loan of $111,081 and grant of $47,919 in 1995 for construction to enlarge Barber Canal and to contract consulting engineering services to develop a rehabilitation plan for the existing concrete structures in the Barber Canal. Total project cost is $191,594. DBWUA will contribute $32,675. Remaining work includes construction work for the second and the fourth phases.

Implementation Strategy

Repair and enlargement of the stilling basins below existing structures and armoring of the outside bends of the Barber Canal is scheduled for completion by December 1996. The feasibility study and design for increasing flow capacity of the three existing drop structures that limit flow capacity has been completed by the Natural Resource Conservation Service. The fourth phase, upgrading the Barber Canal to deliver 300 cfs to the Musselshell River, will be completed by December 1997.

Summary

The Deadman's Basin Water Quality Improvement project was ranked fifth in the *1995 Governor's Report on Water Storage in Montana*. It is ranked second in the prioritization section of this year's report, since the projects ranked second, third, and fourth in 1995 are now either complete or temporarily on hold, and no new rehabilitation projects are planned. This project supports state water plan objectives of integrating water quality and quantity management by encouraging water quality improvement by local water users. The project is well-supported by the local community. This project is preferable to the more costly alternative of stabilizing the streambanks and channel of Careless Creek to accommodate higher flows without extensive erosion and water quality degradation.

PETROLIA DAM REHABILITATION

The Petrolia Dam and Reservoir are located in Petroleum County, on Flatwillow Creek. The dam is approximately 6 miles east and 5 miles south of the county seat of Winnett, Montana. The dam impounds water from Flatwillow and Yellow Water Creeks, tributaries of the Musselshell River.

Description

The existing dam embankment is 59 feet high and the reservoir has a capacity of 8,360 acre-feet. The project currently serves 4,890 acres of irrigated land and supports a warm-water fishery. The maximum discharge capacity of the outlet works is 470 cfs. The capacity of the spillway was rated at 10,200 cfs at the time of construction. The dam is owned by the State of Montana and is operated and maintained by the Petrolia Water Users Association through water purchase contracts with DNRC.

Background

Petrolia Dam was constructed in 1951, and it met dam safety standards at that time. DNRC has conducted annual inspections at Petrolia Dam since the early 1970's. Since then, several operation and maintenance problems were identified and some emergency repairs were made. The Army Corps of Engineers (Corps) inspected the dam under the National Dam Inspection Program in 1980. The dam was classified as *high-hazard* because its failure could result in loss of human life. The Corps declared the dam *unsafe* due to inadequate spillway capacity to route the probable maximum flood (PMF). The reservoir has been operated under a storage restriction until repairs could be made to the spillway. The storage restrictions were part of the conditions of the operating permit for the dam.

In October 1982, DNRC contracted with Morrison-Maierle, Inc. to perform a seepage analysis and preliminary stability analysis of the dam. Morrison-Maierle's report stated that the dam's left abutment was unstable and that the sandstone bedrock was allowing seepage to exit around the left abutment. Morrison-Maierle recommended a detailed stability analysis and further geotechnical studies of the dam (DNRC, 1985).

In 1994, voids were discovered beneath the existing concrete spillway and emergency repairs were performed. Restrictions on reservoir storage and operation were subsequently implemented due to concerns about the condition of the spillway. The restricted operation status prompted a re-examination of the 1986 HKM rehabilitation study.

Implementation Strategy

DNRC's review of the 1986 HKM feasibility report indicates the project can be rehabilitated for approximately $1,434,000, which includes replacing the existing spillway, construction of a new auxiliary spillway, and seepage control in the embankment and left abutment. DNRC has budgeted $1,076,000 for rehabilitation and the Petrolia Water Users Association will pay the balance of $358,000 through an RRGL loan approved by the 1995 Legislature.

Current Status

Work began in the Fall of 1995 with the construction of an earthen auxiliary spillway and seepage control in the left abutment. During the summer and fall of 1996 the principal spillway was replaced with a new concrete and roller-compacted concrete structure capable of passing 9,300 cubic feet per second (cfs) before the auxiliary spillway begins to flow, and after that, up to 21,000 cfs. The new auxiliary spillway has a crest length of approximately 710 feet, and at maximum capacity, will pass approximately 19,000 cfs. The total combined capacity of the two spillways is approximately 40,000 cfs which meets interim dam safety standards. Seepage control is comprised of horizontal wells and a collector drain system. Rehabilitation of Petrolia Dam was completed in November 1996.

Summary

The rehabilitation of Petrolia Dam was ranked second in priority in the *1995 Governor's Report on Water Storage in Montana*. The completed construction allows the water users association to use the full capacity of the reservoir without restriction. The dam now meets current dam safety standards and its ownership is in the process of being transferred to the Petrolia Water Users Association.

BEARPAW LAKE DAM REHABILITATION

Bearpaw Lake Dam is located on Beaver Creek within Beaver Creek Park, which is owned and operated by Hill County. The park is approximately 20 miles south of Havre, Montana.

Description

Bearpaw Lake Dam was constructed in 1958 and is owned and operated by the Department of Fish, Wildlife, and Parks (DFWP). The dam was constructed as a recreational resource and continues to serve that purpose. The zoned earthfill structure stands 59 feet high with a crest length of 380 feet. Lake levels are maintained by a two-bay, uncontrolled overflow chute spillway of reinforced concrete. A gated outlet works is available to release flows downstream as needed.

A center pier and the spillway side walls support a bridge for the road on the dam's crest, which is 20 feet wide. The reservoir's storage capacity is 535 acre-feet at the spillway crest, or normal pool and 905 acre-feet at the dam's crest. The lake's surface area is 36 acres and its drainage contains 49 square miles of land. Beaver Creek Reservoir, located 7 miles downstream, is a multi-purpose flood control, irrigation, and recreation project.

Background

The Army Corps of Engineers (Corps) classified the dam as presenting a "significant downstream hazard" potential in a March 1980 study, which indicated that the dam would be overtopped when 9 percent of a probable maximum flood event (PMF) takes place. In 1989, the dam was classified as *high-hazard* under Montana Dam Safety Act guidelines because of the potential for loss of life in the event of failure. A sudden breach of Bearpaw Lake Dam would damage bridges and the highway downstream and would endanger the lives of campers and recreationists who use the area extensively during the summer. No permanent residences are located downstream of the dam.

Current Status

A feasibility and risk-analysis study was conducted by an engineering consultant to determine whether Bearpaw Lake Dam would require complete rehabilitation, including spillway replacement, to meet Montana Dam Safety Act requirements. The study included a hydraulics analysis of the spillway and outlet works, watershed and flood hydrology, a geotechnical investigation and analysis, the preparation of rehabilitation alternatives, a recommendation of a preferred alternative, preliminary designs and cost estimates, an environmental analysis, and an estimate of future operation and maintenance needs.

It has been determined that repair of the dam will be sufficient to address the safety concerns at the site. Complete rehabilitation, including spillway replacement, would not lessen the impacts to the man-made features resulting from a PMF.

Implementation Strategy

The 1993 Legislature appropriated $260,000 to DFWP for rehabilitation of the dam. The 1995 Legislature approved an additional $210,000 to complete the Bearpaw and other FWP projects. Construction was completed in 1995. Repairs included replacing a portion of the spillway floor and sidewalls, adding a parapet wall to the upstream face to increase freeboard (the distance between the top of the dam and the reservoir), replacing the existing bridge, and relocating the access road to avoid an existing land slump.

Summary

The rehabilitation of the Bearpaw Dam was ranked third in the *1995 Governor's Report on Water Storage in Montana*. DFWP and DNRC have worked with the consultant to determine the appropriate rehabilitation option, and repairs were completed in the summer of 1995.

NORTH FORK SMITH RIVER DAM REHABILITATION

The North Fork of the Smith River Dam and its reservoir, Lake Sutherlin, are located about ten miles east of White Sulphur Springs in Meagher County.

Description

The dam measures 84 feet high and 1,300 feet long at its crest, and stores 11,500 acre-feet of water at the spillway crest. The average storage is 9,000 acre-feet. The water is used to irrigate 11,000 acres of project land and provides considerable recreation opportunities.

Background

The dam was designed and constructed in 1936 to meet the dam safety standards of that time. Owned by DNRC, it is operated and maintained by the Smith River Water Users Association through water purchase contracts. The Army Corps of Engineers (Corps) inspected the dam in 1980, under the National Dam Inspection Program, and classified it as *high-hazard* because its failure could result in loss of human life. The Corps declared the dam *unsafe* due to an inadequate spillway capacity to route the probable maximum flood (PMF). The rehabilitation of the North Fork Smith River Dam was ranked fourth by the state in the *1995 Governor's Report on Water Storage in Montana*. An RRGL loan of $1,393,467 was approved by the 1993 legislature.

Current Status

During the spring of 1989, DNRC contracted with consulting engineers HKM Associates to perform a feasibility study for upgrading the dam to meet current federal and state dam safety standards. The study includes a geotechnical investigation, a flood hydrology analysis and subsequent spillway design, a water availability analysis, a rehabilitation plan with cost estimates for various alternatives, an environmental assessment, and a project evaluation that addresses the financial and economic feasibility of rehabilitation. Final hydrology, geotechnical, and cultural resources reports have been completed. To date, HKM has completed a draft feasibility report. The project presently exceeds the Montana Dam Safety Section interim spillway standards.

Implementation Strategy

At the direction of DNRC, HKM has ceased further work on the feasibility report, pending completion of the *Extreme Storm Event Study* currently being prepared by DNRC and the U.S. Geological Survey. The study, funded by the 1993 Legislature, is expected to have implications for dam spillway design that will tend to reduce the cost of dam rehabilitation.

An amount of $358,000 was re-directed from the $1,393,467 loan approved and authorized for the North Fork of Smith to fund the rehabilitation of Petrolia Dam, a high priority project. The remaining balance of $1,035,467 has been re-authorized for the North Fork Smith River Dam project, pending the completion of the *Extreme Storm Event Study* and re-evaluation by DNRC of the scope of work necessary for the North Fork Smith River Dam.

Summary

Once the *Extreme Storm Event Study* is completed, DNRC will re-evaluate the rehabilitation needs of the project and the dam's former status as *unsafe*. The North Fork of Smith River Dam currently meets interim Montana dam safety standards.

LOWER BAKER LAKE DAM SPILLWAY REHABILITATION

Lower Baker Lake is a man-made lake located a short distance east and south of the town of Baker in Fallon County. It is used by the local public primarily for recreation.

Description

Lower Baker Lake has existed for over 80 years. The lake's dam was built in 1914 by the Chicago, Milwaukee, St. Paul & Pacific Railroad. The lake is an important resource to the residents of the area and to birds and wildlife. The U.S. Army Corps of Engineers (Corps) evaluated the dam's concrete spillway and reported it as being in poor condition. The future of the lake is linked to the integrity of the dam's spillway. It is important that the spillway be replaced before a significant flood occurs.

Background

Fallon County obtained ownership of the Lower Baker Lake Dam in 1977. In 1979, the Corps inspected the dam under the National Dam Safety Program. The inspection report classified the dam as high hazard, since failure of the dam could result in loss of human life, and unsafe due to the deteriorated condition of the spillway. The Corps report concluded by noting that the dam's condition could result in its failure under flood conditions.

The spillway is the only discharge outlet from Baker Lake. If a flood should occur, it is predicted that the existing spillway would fail. This could result in loss of water, land, wetland vegetation, fish, wildlife, birds, recreation, public and private property, and possibly, human life. In 1985, the county attempted to repair the toe of the concrete drop structure which was deteriorating due to undercutting by spillway flows. The concrete spillway has, once again, began to deteriorate.

Implementation Strategy

The proposed rehabilitation project involves replacing the existing spillway to meet requirements of the Montana Dam Safety Act. The existing concrete spillway drop structure would be replaced with a new concrete one. The spillway channel upstream of the structure would be cleared of trees, brush, and vegetation and lined with rock for stabilization. Personnel from DNRC's Dam Safety Program have participated in planning and supporting the proposed project. The project is expected to be completed by December 1996.

Current Status

In 1995, Fallon County was successful in obtaining an RRGL grant in the amount of $31,743. Fallon County contributed a match including administration, surveying, labor, equipment, and materials. An engineering firm has provided the design, bid specifications, and construction specifications. Construction specifications, design, and revisions were approved by the DNRC Dam Safety section in 1995. The engineering firm provided construction monitoring.

In October 1996, the contractor started constructing the concrete drop structure. Small trees and shrubs were removed from the area between the spillway and the lake surface to comply with the Dam Safety Act. This area was leveled and a rock surface installed to prevent erosion. The county has cleared the drop structure construction site and is installing the rock surface in the spillway channel. All design and construction of the spillway has been coordinated with DNRC Dam Safety Program personnel.

Summary

Rehabilitation of the Lower Baker Lake Dam will address the unsafe conditions identified by the Corps and DNRC by replacing the current dilapidated spillway with a new concrete spillway capable of routing two-tenths of the probable maximum flood. DNRC has indicated that the new spillway meets the requirements of the Montana Dam Safety Act.

The project directly implements objectives of the water storage section of the state water plan by allocating state funds to resolve threats to life and property posed by high-hazard facilities in an unsafe condition. This project also meets several criteria for prioritizing rehabilitation of water storage projects including: solving the most severe problems (*unsafe*, *high-hazard* facility); providing multiple uses and benefits (recreation, fish and wildlife, and wetland areas); providing public uses (recreation); is eligible to obtain non-state sources of funding (Fallon County will contribute half of project costs); and protecting and enhancing ecological and aesthetic values and public safety.

LAKE FRANCES EAST DAM REHABILITATION

Lake Frances is located approximately 15 miles northwest of the City of Conrad in the west central region of the state.

Description

The reservoir has a capacity of 112,000 acre-feet of water and is owned by the Pondera County Canal and Reservoir Company, which uses the stored water for irrigation of approximately 65,000 acres. Conrad obtains its entire municipal water supply from the reservoir through a pressurized pipeline originating at the outlet conduit of the Lake Frances East Dam. The City of Conrad water system serves an estimated 3,075 users.

The improvements include excavating the existing pool below the dam, installing intake piping, relocating existing pumps, and adding a new pump, pump house, discharge piping, and controls. The new, 30-horsepower pump more closely matches system average demands than the former 100 horsepower pumps, resulting in energy savings. Water will be conserved by improving the control of discharges from the dam.

Background

Based on inspections of the Lake Frances East Dam in the 1980's, and more recently by Morrison-Maierle, Inc., the Lake Frances East Dam is classified as *high hazard* because its failure has the potential for loss of human life. An inadvertent pressurization in the section of the city's water supply pipeline, (the outlet conduit located within the east dam's earthfill embankment) could saturate the dam resulting in the dam's failure. Removal of the outlet conduit and other improvements will eliminate this risk. Several major system upgrades have occurred in the last 25 years including: 1) the replacement of 65,000 lineal feet of pipeline; 2) the construction of a direction filtration plant; and 3) the construction of two 1-million gallon storage tanks. The improvement of the city's water system will enhance public health and safety.

This project is required because the dam's outlet pipe was not designed to accommodate pressurized flows, a condition of approval imposed by DNRC for issuance of a Dam Safety operation permit. The total estimated project cost is over $600,000. The City of Conrad received a $50,000 RRGL grant for construction from the 1995 Legislature, a $180,000 TSEP (Treasure State Endowment Program) grant, and a $5,000 Montana Power Company grant from its Efficiency Plus Business Partners Program. The city will borrow approximately $250,000, and contribute the remainder in administrative services.

In 1982, the city conducted a study to determine what alternatives were available for diverting water from Lake Frances to Conrad. The three alternatives studied ranged from $670,000 to $1,400,000 in cost. A 1994 study determined that an alternative involving alterations to the outlet pool below the dam would cost $360,000.

Current Status

The project was completed in November 1996, with the exception of some detail work.

Summary

The rehabilitation resulted in a cost effective solution to the City of Conrad's water supply needs and addressed the potential threat posed to the dam. The total project cost was approximately $600,000. The City of Conrad received $50,000 RRGL grant from the state legislature, a $180,000 TSEP grant, and a $5,000 Montana Power Company grant. The City of Conrad will cover the remainder by borrowing approximately $250,000 and providing administrative services.

This project directly implements objectives of the state water plan section on water storage. It allocates state funds for water storage rehabilitation projects based on resolving threats to life and property posed by *high-hazard* dams that are in *unsafe* condition and improving or expanding existing water storage facilities. If the Lake Frances East Dam were to fail, not only would a serious threat to downstream life and property occur, the sole water supply source for the City of Conrad would be eliminated, resulting in an urgent and serious public health problem.

LONE TREE DAM REHABILITATION STUDY

The two Lone Tree, or Vaux Dams, are located on Lone Tree Creek three miles west of Sidney, Montana.

Description

Lone Tree Ranch, Inc. is the owner of both dams. The existing project consists of two earthfill dams known as Vaux I and Vaux II. Vaux II is located one-half of a mile upstream of Vaux I and impounds 600 acre-feet of water at normal pool and 1175 acre-feet at the crest of the dam. As of November 1992, Vaux I was drained and Vaux II filled to normal pool level. Vaux I, the lower dam, impounds 250 acre-feet at normal pool and 685 acre-feet at the crest and provides the only regulation for irrigation releases. The Lone Tree Creek drainage measures approximately 83 square-miles in area.

Background

The dams were constructed originally to provide the Lone Tree Ranch with irrigation water. The original Vaux I was built in 1936 and measured approximately 20 feet high. The original Vaux II dam was built in 1944. In 1947, the height of Vaux II was raised to 40 feet and a spillway was constructed.

On March 26, 1951, both the Vaux I and II dams failed from overtopping during a high precipitation flood event. An ice jam on the crest of the Vaux II dam prevented the spillway from passing the flood waters. After overtopping, a 200-foot section of the north abutment washed out. This caused Vaux I to overtop, washing out a 400-foot section of its south abutment. The failure caused extensive downstream flooding, including portions of Sidney. Although there was significant property damage in Sidney, no human lives were lost. Reconstruction of the dams in 1960 involved repair of the breached sections on both dams, and construction of a new spillway at the Vaux II Dam.

A 1978 engineering study by the U.S. Army Corps of Engineers resulted in the Lone Tree Dams being classified as *high-hazard* because of the threat to human life in the event of dam failure, and *unsafe* due to the inability of the dam spillways to route the probable maximum flood (PMF). This classification was based on the potential for loss of human life in the event of dam failure. Lone Tree Ranch, Inc. considered breaching the dams to relieve itself of liability in the event of failure since the irrigation needs of the ranch had decreased over the years and the cost of rehabilitation was determined to be prohibitive.

Local city and county government became concerned about losing the flood protection that the dams had provided during small flood events. However, efforts made by the county

to obtain public funding to repair the dams were unsuccessful. Richland County was unsuccessful in securing $531,250 in 1995 from both the DNRC Renewable Resource Grant and Loan Program and the Treasure State Endowment program to repair the dams, primarily because the dams were privately owned and the flood retention capacity was minimal. In 1995, the dam owners decided to breach Vaux I Dam and to reduce the holding capacity of Vaux II dam to less than fifty acre-feet to avoid the regulatory reach of the Montana Dam Safety Act.

Summary

In the fall of 1995, Vaux I Dam was removed and the holding capacity of Vaux II was reduced. Vaux II Dam continues to provide water for irrigation. The owners are considering an increase to the storage capacity of the Vaux II Dam to provide additional irrigation water.

TIN CUP LAKE DAM REHABILITATION

Tin Cup Lake Dam is located at the headwaters of Tin Cup Creek, near the Montana-Idaho border, approximately 14 miles southwest of Darby, Montana. The dam is located within the Selway-Bitterroot Wilderness Area of the Bitterroot National Forest.

Description

Tin Cup Lake Dam is an earth embankment structure 25 feet high. The dam has a crest width of 10 to 17 feet and a crest length of 437 feet. The dam has an active storage capacity of 2,420 acre-feet. The total storage capacity, to the dam crest elevation, is 2,800 acre-feet.

The primary purpose for the dam is to store water for irrigation and supplement the natural creek water supply during late summer. The dam supplies irrigation water to approximately 1,300 acres of farmland. Additional benefits of the dam include limited flood control, ground water recharge, enhancement of instream flows for fisheries, public recreation opportunities, and improved water quality through the control of streambank erosion and stream sedimentation.

Background

Several modifications to the dam have been made since 1906 when it was originally constructed. However, the active storage of the dam has not been increased over the years. The dam is owned and operated by the Tin Cup Water Users Company, an organization of 54 local farmers and ranchers. The Tin Cup Water Company has applied to the state to form a public water district.

Current Status

Tin Cup Lake Dam was inspected by the U.S. Army Corps of Engineers (Corps) in 1980 under the National Dam Inspection Program. The dam was classified as *high-hazard* by the Corps, the U.S. Forest Service, and DNRC due to the potential for loss of human life in the event of dam failure. At least four residences, several private, county, and state roads, bridges and utilities, and several hundred acres of agricultural land would be adversely impacted if the dam failed. The Corps further determined the dam to be *unsafe* because of inadequate spillway capacity to route the probable maximum flood (PMF). The composition of the dam's inner core is currently being investigated. If the existence and configuration of the core can be verified, the dam's classification as unsafe will likely change. The USFS will ultimately determine what spillway capacity is required.

Implementation Strategy

The Tin Cup Water Company contracted with the consulting engineering firm of Druyvestein, Johnson and Anderson to develop alternatives for bringing the dam into compliance with current dam safety standards. Investigation of the dam is still being conducted and the consultant has recommended the following steps to address compliance with safety standards:

1) Attempt to verify the existence and configuration of the core in the fall of 1996. This will be attempted with non-destructive or remote testing methods since it is impractical to get drilling equipment to the wilderness site.

2) Construction to repair or replace the inlet and outlet works will be done during the fall of 1997, regardless of the results of the core testing. Work planned for this phase includes replacing or lining the existing stone and mortar box culvert, replacing the existing log tower and inlet crib, and installing a reservoir recording device. If the hazard classification has not been determined by the fall of 1997, the existing spillway crest will be lowered to provide more reservoir routing capacity for runoff events.

Additional work being considered is:

a. Improve the existing embankment by raising the dam crest approximately two feet, regrade and establish a constant slope on both the upstream and downstream faces of the structure, and place additional riprap protection on the upstream face of the dam.

b. Raise the spillway crest if it is lowered as described above and improve the spillway by replacing the existing deteriorated rock and mortar spillway crest, widen the spillway by approximately 20 feet, and upgrade the existing debris log boom arrangement and add additional riprap to the inlet and outlet channel slopes.

Druyvestein, Johnson, and Anderson has estimated the cost of rehabilitation to be $280,742. An RRGL loan of $304,204 at 3 percent interest for 20 years was approved by the 53rd Montana Legislature for the dam's rehabilitation.

Summary

The Tin Cup Water Company is in the process of becoming a public entity to qualify for use of its approved loan. Work required for compliance with dam safety standards will be reduced. Some repair work is necessary due to the condition of the dam and spillway.

MALTA IRRIGATION DISTRICT CANAL EFFICIENCY IMPROVEMENT

The proposed project would increase the efficiency of the Dodson South Canal to deliver water from the Milk River to Nelson Reservoir, approximately 20 miles northeast of the town of Malta, in northcentral Montana.

Description

The Dodson Canal water distribution system is operated and maintained by the Malta Irrigation District. The project consists of rebuilding eight check structures in the Dodson South Canal. The completed project would allow an additional 13,000 acre-feet of water to be stored annually at Nelson Reservoir. Increased storage would allow water to be conveyed more efficiently into Nelson Reservoir. The projected cost is $498,000.

Background

The Malta Irrigation Project was constructed between 1909 and 1923 and includes 42,492 acres. The Malta Irrigation District is responsible for operating and maintaining the Dodson South Canal. The U.S. Bureau of Reclamation conducted an irrigation system rehabilitation and betterment study and concluded that new check structures were needed to improve the efficiency of the irrigation system. When water in the canals is at less than full capacity, check structures would raise the water high enough in the canal for it to pass through the turn-outs in the canal banks. The new automated check structures will be designed to Reclamation standards and will have two 10-foot wide bays instead of the current 5-foot wide openings.

The automated check structures will allow water to be stored at Nelson Reservoir beginning two weeks earlier each spring. During springtime, melting pieces of ice tend to block flows through the 5-foot check structures. The two 10-foot bays of each structure will allow ice to pass through with less difficulty. It is important to begin storing water at Nelson Reservoir as early in spring as possible to avoid conflict with piping plover nesting, which occurs from May 1 to July 15 on the reservoir shoreline. This migratory shorebird is classified as a threatened species under the national Endangered Species Act. Storage of additional water after May 1 may result in flooding of nesting areas which can increase mortality rates of the piping plover.

Reclamation has an agreement with the U.S. Fish and Wildlife Service to maintain water levels in Nelson Reservoir that are compatible with the critical plover nesting period. Storing water before the piping plover nesting period is also important to the local agricultural economy. The majority of local runoff usually takes place over a very short time period. It is estimated that at the maximum flow of 500 cubic feet per second, the proposed automated check structures will allow the storage of an additional 13,000 acre-feet of water each year without interfering with the piping plover nesting season. Bowdoin National Wildlife Refuge, which contains 8,000 acres of waterfowl habitat, receives water from the Milk River via the canal system, and would benefit from the proposed project by receiving additional water earlier than usual.

Current Status

The Malta Irrigation District received a $50,000 RRGL grant from the 1993 Legislature. The estimated cost of the proposed project is $498,000. The difference will be covered by the Malta Irrigation District through user fees. Seven of the eight check structures have been installed. Installation of the eighth, and final structure, was started in October 1996 and is expected to be complete in November 1996. The grant originally extended through December of 1997. The applicants have requested an extension through March 1998, so installation of the last check structure does not conflict with the 1997 irrigation season.

Summary

A study by Reclamation of the Malta Irrigation District irrigation system found that new check structures at Dodson Canal South were critical to keeping the water distribution system operational. The proposed project provides more water for irrigation, migratory bird habitat, and recreation. The Malta Irrigation District and the Glasgow Irrigation District will benefit from the increased ability to store water within seasonal and environmental constraints. Public flatwater recreation opportunities should increase at Nelson Reservoir due to the increase in pool size. Fish habitat should be improved with the increase in reservoir volume. The potential exists for more storage at Bowdoin National Wildlife Refuge, which will benefit bird and wildlife habitat. No citizen opposition to the project was documented.

In conclusion, the proposed project will increase the efficiency and rehabilitate the existing water conveyance system. Approximately three quarters of the project funds will be generated by the irrigation districts through user fees. The project will also reduce seepage from the canal and decrease the salinity of adjacent lands, improving water quality. The proposed project benefits are supported by goals identified in the state water plan, and the legislation governing the allocation priorities of water storage funding.

BASS LAKE DAM REHABILITATION

Bass Lake Dam is located on the west side of the Bitterroot Valley on the Bitterroot National Forest, in the Selway-Bitterroot Wilderness, northwest of Stevensville.

Description

The 100-acre reservoir has a capacity of 3600 acre-feet, and supplies irrigation water for 8,000 acres of farm and ranch land. The reservoir additionally provides supplemental flow in summer for recreation and the fisheries of Bass Creek and the Bitterroot River. The dam is owned and maintained by the Bass Lake Reservoir Co., a coalition of farmers and ranchers that use the water for irrigation. Bass Lake Dam is classified as *high-hazard* since its failure has the potential to take human lives.

Background

Bass Lake Reservoir Co. built the dam in 1952, which enlarged Bass Lake from its natural size of forty acres to its present size of one hundred acres. For years the dam was accessed for maintenance purposes by a vehicle track that paralleled Bass Creek up the steep and rocky canyon. Access to the dam with motorized vehicles and maintenance with mechanized equipment became restricted by the Forest Service with the creation of the Selway-Bitterroot Wilderness, although a dedicated easement pre-dated the wilderness. An environmental impact statement was prepared by the Forest Service to address concerns of environmental groups and the dam owners to determine an acceptable plan for the necessary repairs.

Current Status

Rehabilitation of Bass Lake Dam required coordination between the Forest Service and the dam owners for mechanized equipment to be driven and flown to the site for the project. The dam owners retained Druyvestein and Associates to plan and oversee the dam rehabilitation which included the replacement of a 240-foot outlet pipe and widening of the spillway to accommodate a 100-year design flood event.

The dam rehabilitation work began August 10, 1996 and was completed in one month. The new, 24-inch plastic outlet pipe was slipped inside the existing 30-inch metal outlet pipe. About 2,000 cubic yards of rock rip-rap were added to the face of the dam to increase its strength. Rehabilitation of the pathway used by heavy equipment to access the project is planned for completion by October 1996. The trail was reopened to the public on August 12. The total project cost was approximately $280,000.

Summary

The Bass Lake Dam rehabilitation project may serve as a model for several other upcoming dam repair projects located on national forest lands and within wilderness areas. It should be noted that the dam sites and their access routes are excluded from the wilderness areas and the restrictions that apply there. However, special measures are taken to avoid impacts to the adjacent wilderness areas both at the dam sites and while accessing the sites with equipment needed for repair.

CANYON CREEK DAM REPAIR

Canyon Creek Dam is located on the Bitterroot National Forest five miles inside the Selway-Bitterroot Wilderness and west of Hamilton, Montana.

Description

The dam is owned and operated by the Canyon Creek Irrigation District and is capable of holding 425 acre-feet of water, used primarily for the irrigation of farm and ranch land in the Bitterroot Valley. Canyon Creek Dam was built in 1891 by the Canyon Creek Reservoir Company and enlarged in 1908. Canyon Creek Dam is classified *high-hazard* because human life would be threatened in the event of a dam failure.

Background

Following the accumulation of a near record mountain snowpack for the winter of 1995-96, heavy spring runoff overtopped Canyon Creek Dam resulting in damage to the structure. According to an engineering report, the overtopping was the result of icing and debris blocking the dam's spillway and a lack of clearance to pass the runoff. The dam was inspected in August 1996 by representatives of the Forest Service and the irrigation district and it was determined that the dam was not, at that time, in danger of breaching. Subsequent inspection of the dam by the irrigation district's engineer, and engineers with the Montana Dam Safety Program, indicated that the dam's structural integrity would be threatened by an additional runoff event and would need immediate repair.

Current Status

Emergency repair to the dam began September 22, 1996 and was completed on October 1. Repair involved flying in a small excavator and all-terrain vehicle to replace 55 cubic yards of fill material lost from the dam embankment during the snowpack runoff in spring of 1996. The total cost of repair was $59,000, which was paid for by the Canyon Creek Irrigation District. The repairs completed in September will allow the irrigation district to continue providing water. Additional work may be necessary in the near future to re-line or repair the dam's outlet pipe and widen the dam spillway.

Summary

There has been no major rehabilitation to the Canyon Lake Dam since its enlargement in 1908. The Canyon Creek Irrigation District plans to hire an engineering consultant to provide the district with a complete rehabilitation needs assessment.

DELMOE LAKE DAM

Delmoe Lake Dam is situated about twenty miles northwest of Whitehall, Montana in heavily-timbered country at an elevation of 6,100 feet above sea level.

Description

Built in 1914, the earth-filled dam is capable of impounding 9,900 acre-feet of water and is owned by the Pipestone Water Users Association. At 310 acres in size, Delmoe Lake is a popular destination for local recreationists, although irrigation of local ranch land is the primary use of its water.

Background

Inspection of the dam in October 1994 revealed that seepage from the reservoir was becoming a problem. The Pipestone Water Users Association retained MSE/HKM Engineering, Inc. to develop a solution. It was determined that the best approach was to add a toe berm to increase stability, and a drainage system to control seepage. Delmoe Lake Dam is classified as *high-hazard* since its failure would threaten the safety of people using Interstate Highway 90 and the Pipestone Creek corridor.

Status

Construction of the drainage system and toe berm took about two weeks and was completed in August of 1996 without completely draining Delmoe Lake. The approximate cost of the project was $25,000, which was covered by the water users. A timely response by the Pipestone Water Users Association to the seepage problem prevented additional damage to the downstream toe of the dam, and ultimately, prevented a significant increase in the cost of repair.

Summary

Delmoe Lake Dam now meets applicable standards of the Montana Dam Safety Act. Future plans include performing scheduled dam inspections to monitor drain flows and seepage through the dam.

EAST FORK OF ROCK CREEK DAM REPAIR AND REHABILITATION

East Fork of Rock Creek Dam is located in south Granite County, at the headwaters of the East Fork of Rock Creek, about 30 miles west of Anaconda. The East Fork flows northwesterly for 13 miles before joining the Middle Fork and the West Fork to form Rock Creek, a tributary of the Clark Fork River.

Description

The earthfill dam is 25 feet wide at its crest to over 500 feet wide at its base, 83 feet high, and 1075 feet in length at the crest. The reservoir has a storage capacity of slightly more than 16,040 acre-feet and a surface area of 420 acres. East Fork Dam is classified as *high hazard*, since in the event of a failure, human life would be threatened. During the irrigation season, reservoir water is routed to the east, into the Flint Creek drainage, via a canal that traverses a mountain side before emptying into Trout Creek, a tributary of Flint Creek. During the remainder of the year water spilled, or released, is allowed to flow through a headgate into the East Fork drainage.

Background

Built in 1938, East Fork Dam is owned by the state, managed by DNRC, and used primarily as a supply for the 44 irrigators of the Flint Creek Water Users Association (Association). On June 29, 1996, a Forest Service employee reported muddy water flowing from a drainage pipe in the main embankment of East Fork Dam. DNRC, the association, and the Granite County Sheriff were notified of the situation and after confirming the situation, arrangements were made for 24-hour per day monitoring of the dam. Reservoir releases were increased immediately to alleviate pressure against the dam and reduce the potential of a breach, or failure. The reservoir was full following an abundant spring mountain snowpack runoff.

The level of silt in the water leaving the drainpipe decreased slightly over the first three days of July. On July 4, turbidity increased significantly and a sinkhole appeared on the downstream face of the dam embankment, directly above the main drain pipe. Sinkholes occur, generally when movement of earth or fill material beneath the surface results in the downward collapse of surface material into the void below.

Discovery of the sinkhole heightened the concern of officials regarding the structural integrity of the dam, and prompted the sheriff's decision, on July 5, to order the evacuation of downstream residents and prohibit recreational activities in the valley below. The evacuation order remained in effect until July 18, when it was determined that the reservoir contents had been lowered to a safe level. As the reservoir level was lowered, the amount

of sediment in the seepage water decreased, a positive sign that pressure within the dam had been relieved. By early September, the reservoir was lowered to a level of slightly less than 200 acre-feet.

MSE-HKM Engineering of Billings was retained as consulting engineers to investigate the dam and design plans for repair and rehabilitation of the dam. The area adjacent to the lower section of the main drain was excavated to provide access for the investigation. Video camera inspection of the corrugated metal drain pipes in the dam foundation by Pace Construction of Billings, revealed that the pipes were corroded and filled with silt. The sinkhole on the downstream face of the dam indicated that material within the embankment had migrated into the drain and out of the dam, leaving a void above the pipe. Increased water pressure in the bedrock beneath the dam embankment had brought the stability of the dam into question. Finally, holes discovered in the clay blanket liner on the east abutment above the dam had allowed water to seep under the dam.

Implementation Strategy

The repair and rehabilitation plan includes the following steps:

- Replacement of the 12-inch diameter metal main drain pipe with a plastic 12-inch pipe and replacement of the original gravel and sand filter with a new graded filter;
- Installation of a new drain pipe on the east side of the dam to drain seepage and relieve pressure on the main drain pipe and the cross-drain that intersects it;
- The in-place lining of the 10-inch metal drain pipe in the west abutment to prevent future corrosion;
- The addition of a berm to the toe of the dam to increase its stability;
- The installation of a series of ten pressure relief wells near the dam's toe into material above the bedrock and in the bedrock itself to release artesian pressure from below the dam embankment;
- The addition of new drains and a collection system at the dam toe to collect seepage from the dam embankment and foundation; and
- The repair and rehabilitation of 90,000 square feet of clay blanket that extends upstream from the dam along the east abutment. Seepage has managed to work its way around the dam due to holes in the clay blanket that have developed over time, most likely due to years of freeze-thaw seasonal cycles. The holes in the clay blanket, or liner, will be repaired and additional clay will be added and covered with a thick layer of soil before the reservoir is re-filled in spring.

Mungas Construction, of Phillipsburg was the general contractor, O'Keefe Drilling of Butte installed the monitoring and relief wells, and Gelco/Insituform of Salem, Oregon, installed the pipe liner.

Plans are being made for the installation of an emergency early warning system for the protection of the residents of the Rock Creek drainage using a system of pressure sensors in the reservoir and at the toe of the dam that would allow the monitoring of water levels electronically and remotely.

Status

The East Fork Dam repair and rehabilitation project has been underway for two months. Monitoring and relief wells have been drilled and new drain pipes were installed. The area surrounding the main drain pipe was excavated to allow the removal of the corroded metal pipe and the laying of the new pipe. Fill material is being hauled to the reservoir's west bank where it is sorted for desired size and purpose. As of the second week of December 1996, pipe was being installed beneath the toe berm zone, after which the toe berm will be constructed.

The total cost of the repairs and rehabilitation is estimated to be approximately $1.4 million. The Flint Creek Water Users (FCWUA) will borrow $1 million from the sale of bonds with a 20-year term. FCWUA also contributed their entire emergency reserve fund of $60,000 to the project. The state will contribute $370,000, which includes $102,760 in interest earnings from the special storage revenue account, $110,000 from the Governor's Environmental Contingency Account, $85,800 from the state's Broadwater Hydropower Earnings Account, and a $71,484 RRGL grant to DNRC.

DNRC has conducted several on-site tours of the dam site to provide local residents, the media, and the general public an opportunity to inspect the progress of work and hear the engineers explain the various aspects of the repair and rehabilitation.

Summary

The rehabilitation and repair of East Fork Dam has resulted in the stabilization of a potentially catastrophic situation. The state and the water users have taken the measures necessary to ensure the long-term safety and security of the residents of Rock Creek, the viability of the Flint Creek Valley economy, and the livelihoods of the families that depend upon the stored water for irrigation of their lands.

WILLOW CREEK DAM REPAIR

Willow Creek Dam is located in Lewis and Clark County, near the town of Augusta, approximately 55 miles west of Great Falls.

Description

The dam, which is a feature of the Sun River Irrigation Project, is owned by the U.S. Bureau of Reclamation and operated and maintained by the Greenfields Irrigation District. The Fort Shaw Irrigation District also uses water stored in Willow Creek Reservoir through a separate agreement between the two Districts which addresses operation and maintenance costs.

Since its construction in 1911, Willow Creek Dam has been raised twice: two feet in 1917, and 14 feet in 1941. The reservoir capacity is 32,300 acre-feet of water at the top of the active conservation pool. The earth-filled dam has a structural height of 93 feet and a crest length of 650 feet. The dam's spillway, located approximately 3,600 feet north of the dam, is comprised of a 700-foot long concrete grade control sill. The outlet works consists of a 54-inch diameter concrete-lined tunnel through the right abutment of the dam, and has a release capacity of 500 cubic feet per second (cfs).

Background

On June 28, 1996, a large sinkhole, measuring twenty feet in depth, three to six feet in diameter at the surface, and about 18 feet in diameter at the bottom, was discovered in the crest of the dam. The sinkhole was located directly above the outlet works tunnel and about fifty feet downstream of the regulating gate. Reclamation and Greenfields personnel immediately initiated temporary emergency repairs to the dam to prevent additional loss of embankment material, which would have further threatened the integrity of the structure.

Repairs included plugging and patching holes in the outlet tunnel, excavating and shaping the sinkhole in preparation for backfilling, and filling the sinkhole with approximately 200 cubic yards of well-graded sand and gravel. Following completion of temporary repairs, water was released from the reservoir at the rate of 300 cfs to decrease hydraulic load pressure on the damaged structure. Greenfields and Reclamation provided 24-hour surveillance of the dam until a safe reservoir level was reached and the dam was functioning adequately.

Dam operations records indicate that development of the current sinkhole is related to a 1958 collapse of the outlet works tunnel when approximately 50 linear feet of the concrete outlet tunnel, downstream of the regulating gate, was damaged as a result of inadequate air ventilation during a period of high reservoir releases. A large void within the foundation

was created around the outlet works following the collapse of the tunnel. Repairs to the dam and its outlet tunnel were initiated in late 1958. The void above the crown of the tunnel was back-filled with large, randomly-sized rock and fill material, although the void was probably not completely filled. Repairs were also made to the concrete-lined tunnel, which included the drilling of weepholes in the lining and the drilling of a 12-inch diameter hole from the crest of the dam downward to access the outlet tunnel.

Since the 1958 repair, it appears that piping of foundation and embankment materials has been occurring through these weepholes, further enlarging the void. The former 12-inch drill hole appears to have provided a path for seepage to move embankment materials through the foundation and into the outlet works tunnel.

Status

Willow Creek Reservoir has been drawn down to approximately 5,000 acre-feet of storage to facilitate permanent structural repairs to the dam. Since discovery of the sinkhole, Reclamation has been conducting investigations of the outlet works tunnel and the structural integrity of the dam, and preparing design work for the repairs. Repair work was started September 9. As of December 1, 1996 the grouting work, which consists of pumping cement into the area beneath the dam and into the void surrounding the outlet works tunnel, and the reconstruction of the embankment in the vicinity of the sinkhole, have been completed.

Implementation Strategy

Repair will include the excavation and replacement of a portion of the right abutment of the dam, cement grouting of the foundation bedrock beneath the dam, and lining of the outlet works tunnel. The irrigation districts are performing a portion of the repair work and Reclamation will contract the remaining work. Reclamation has taken the lead in conducting the investigations, preparing the designs for repairs, and providing project oversight. The total cost estimated for the repair project is approximately $1.6 million.

Summary

The large sinkhole in the crest of Willow Creek Dam discovered June 28, 1996 was related to damage sustained to the dam's concrete outlet works tunnel during a period of high reservoir releases in 1958. The procedures employed during repairs to the dam's outlet works tunnel in 1958 would not meet contemporary dam repair standards, and over time have served to compromise the structural integrity of the dam, resulting in the current problems. Reclamation has estimated that repairs will be completed in the spring of 1997.

COMO LAKE DAM REPAIR AND REHABILITATION

Como Lake Dam is located on the east slope of the Bitterroot Range, approximately 15 miles south of Hamilton in extreme western Montana. The reservoir, Lake Como, is fed by Rock Creek, a mountain stream that drains an alpine valley originating on the Continental Divide.

Description

Como Dam is an earth-filled dam built between 1908 and 1910 by local irrigators and owned by the Bitterroot Irrigation Company. The dam measures 70 feet high and has a crest length of 2,565 feet. Lake Como's total storage capacity is 39,000 acre-feet and its surface area is 913 acres. Water is released from Lake Como during the summer to irrigate 16,635 acres of land within the Bitterroot Irrigation District for the production of alfalfa, grain, and livestock pasture.

Background

Lake Como's water is stored during the spring when the drainage's mountain snowpack melts. The lake provides a variety of flatwater recreation opportunities to residents of Ravalli County and the state. The site's average annual precipitation is 60 inches. By September the reservoir portion of the lake is nearly empty.

Starting in 1984, Como Dam was the subject of detailed and intensive investigations under the federal Safety of Dams Program. Observations made during reservoir filling and draw-down cycles during a three-year period provided documentation of more than 50 recorded physical symptoms indicating movement and piping within the dam embankment. This indicated that widespread internal erosion of foundation materials was taking place, which compromised the stability of the dam.

In 1991, the acceleration of abnormal conditions indicated that it was no longer safe to operate the dam in the normal manner. Lake Como's surface elevation was lowered by 8.7 feet during the 1991 irrigation season, resulting in a reduction in reservoir capacity of 8,000 acre-feet (25 percent). In 1992, as the reservoir filled to the restricted level, additional evidence of extreme stress indicated that a progressive dam failure could be taking place. On June 19, 1992, emergency draw-down of the reservoir was commenced.

Seismic investigations at Como Dam revealed that the materials and methods used in constructing the dam in 1910 were vulnerable to the phenomenon known as *liquefaction*. Under liquefaction, low-density materials, such as those that comprise the Como Dam embankment, lose their supportive strength and assume the physical properties of a fluid. Como Dam possessed a significant risk of failure during an earthquake because the associated shaking of the ground causes liquefaction.

A hydrologic evaluation of Como Dam indicated additional potentially hazardous conditions. For Como Dam, the probable maximum flood (PMF) caused by a severe thunderstorm presents the most severe scenario for inhabitants of the floodplain below. It was estimated that a flood exceeding 67 percent of the PMF for a thunderstorm would overtop Como Dam and cause it to fail.

On July 27, 1992, the Bureau of Reclamation (Reclamation) completed a Safety of Dam modification report on Como Dam that went to Congress on August 17, 1992. On August 14, 1992, a basis of negotiation for repayment by the Bitterroot Irrigation District of 15 percent of Safety of Dam program costs was approved by the district and the Commissioner of Reclamation. The 1993 Water and Energy Appropriation Bill waived the required 60-day Congressional review required for the expenditure of construction funds.

On August 25, 1992, the primary construction contract was awarded to Barnard Construction Company, Inc. of Bozeman for $2.9 million. Construction of features that provide embankment stability and prevent internal erosion of embankment and foundation materials were completed in 1994.

Current Status

The rehabilitation of the dam, completed in May 1995, provided an additional 3400 acre-feet of storage targeted primarily for instream flow maintenance during late season periods. The new spillway meets federal and state standards. The rehabilitation included improvements to the Forest Service recreational facilities near the dam and around the shoreline of the reservoir.

Summary

The design and construction technology used in 1910 were directly responsible for the internal erosion of embankment material at Como Dam. Methods employed during the original construction are now known to contribute to unstable embankments that can slump and fail during earthquakes. The condition of Como Dam was of great concern to the people of Ravalli County and of Montana. The Como Dam repair project represents a successful, coordinated response to a potentially catastrophic situation.

NEW STORAGE PROJECTS

There is one proposed storage project currently under study:

The site proposed for the Ruby Creek storage project is located in the upper Big Hole Valley, approximately 10 miles west of Wisdom, Montana and two miles east of the Montana-Idaho border. A pre-feasibility study is being conducted by DNRC with assistance from the U.S. Bureau of Reclamation's Montana Projects Office, and the cooperation of upper Big Hole Valley irrigators and Montana DFWP.

The Cherry Creek Reservoir proposal has been inactive since March 1995, when preliminary work ceased due to lack of funding for further study. The site proposed for the Cherry Creek Reservoir Project is located near Terry, Montana on land managed by the Bureau of Land Management (BLM). The project is intended to provide recreational opportunities for visitors and residents of the region. The project was reported in the 1995 Governor's water storage report, but has been inactive since March 20, 1995 when BLM notified the sponsors that, given governmental fiscal constraints, the preliminary project work could not proceed. No state funding is currently being requested for the project.

RUBY CREEK WATER STORAGE STUDY

The site proposed for the Ruby Creek Reservoir is located on Ruby Creek 10 miles west of Wisdom, Montana and two miles east of Big Hole Pass and the Montana-Idaho border.

Description

Ruby Creek originates along the Continental Divide on the east side of Big Hole Pass in the Beaverhead National Forest. Ruby Creek is a perennial stream and a tributary of the North Fork of the Big Hole River. Ruby Creek meets Trail Creek eight miles north of the proposed reservoir to form the North Fork of the Big Hole River, which enters the Big Hole National Battlefield, 10 miles west of Wisdom. Several small tributaries join Ruby Creek above the proposed impoundment area, which is located at an elevation of 6664 feet above sea level. Ruby Creek historically provides irrigation water for native hay crops on several ranches in the upper Big Hole River Valley.

The proposed dam would measure 60 feet in height, 2100 feet in length, and would impound about 4,000 acre-feet of water, creating a reservoir surface area of 180-200 acres. The project would supply supplemental water to 1,000 acres of irrigated lands and a firm yield of water to Swamp Creek, spawning habitat for the threatened fluvial arctic grayling. The applicant is the Ruby Water Company of Wisdom.

One aspect of the proposal involves supplementing streamflow in nearby Swamp Creek, which is a primary spawning stream for the only remaining native population of river-dwelling arctic grayling in the contiguous 48 states. Water from Ruby Creek can be diverted to Swamp Creek via a small irrigation canal that transverses the gentle divide between the drainages of Ruby and Swamp Creeks. The fluvial arctic grayling is listed as a "Species of Special Concern" by Montana DFWP. The fact that this proposal would provide additional benefit for the grayling increases its potential for broader support by the public and government.

Background

Reclamation contracted some project work with the U.S. Geological Survey (USGS) due to its expertise in water measurement. The U.S. Forest Service (USFS) has an interest in the project since the proposed reservoir site lies on USFS land, and a small population of the threatened westslope cutthroat trout resides in the upper reaches of Ruby Creek and its tributaries.

The Natural Resources Conservation Service (NRCS), studied the feasibility of a water storage project at this site in the late 1960's. In 1968, a report to the present applicants indicated that the cost of a 60-foot high dam storing 3600 to 4000 acre-feet of water would be approximately $300,000. The project was not pursued because the applicants were unsuccessful in negotiating a land trade with the USFS for a portion of land that would be inundated by the reservoir.

The 1991 Montana Legislature granted the applicants a water development grant of $14,708 to conduct a feasibility study of the proposal. The applicants met with representatives of DNRC, DFWP, USFS, and Reclamation in August 1993 to visit the project site and to plan the studies needed to determine economic and hydrologic feasibility. Reclamation provided technical assistance in 1994 to DNRC and the applicants for this phase of the study under its Technical Assistance to States program. Continued assistance under this program was requested by DNRC for 1995-96 and approved by Reclamation.

A network of five stream gauging stations was activated from May 1994 through October 1994 to gather streamflow data on Ruby and Swamp Creeks and three canal locations. The flow data was used to develop a hydrologic model for the Ruby and Swamp Creek basins. The 1994 flow data and model conclusions were presented in a draft report titled, *"Ruby Creek Water Availability Study Near Wisdom, Montana."* The 1994 report indicated that sufficient water may be available for the project. Using the Reclamation "Construction Cost Index," the cost to build the reservoir would be $1.2 million. The decision was made to collect additional streamflow and water supply data through the 1996 water year, since an adequate period of record had not been established for the site.

Current Status

The network of gauging stations established in 1994 and active from May 1994 through October 1994, was activated again from April 1995 through December 1995, and from April 1996 through October 1996. Reclamation contracted the operation of the West Fork of Ruby Creek and the Swamp Creek gauges to the USGS for the 1995 and 1996 seasons. The remaining streamflow measurement gauges were operated by Reclamation and DNRC. With the completion of the 1996 water year, Reclamation removed its data recorders from the streamflow gauging network. Reclamation will forward summaries of the 1995 and 1996 streamflow data to DNRC for further analysis.

Implementation Strategy

DNRC will begin a pre-feasibility analysis of the project in fall of 1996. Water supply data derived from the streamflow measurement network, and collected by USGS and Reclamation between spring of 1994 and fall of 1996, will be modeled to reach conclusions for the project pre-feasibility analysis. DNRC will study the economic value of the project with respect to the benefits it may provide. Finally, the cost of planning, design, and construction, expressed in current dollars, must be determined. The cost of engineering and construction has increased dramatically since 1968, when the SCS (now NRCS) estimated project costs. DNRC will present the project applicants with the results of the feasibility study for the Ruby Creek storage proposal in 1997. The applicants will decide whether or not to proceed with the proposal and to seek additional funding following the presentation of the DNRC study.

Summary

The Ruby Creek storage proposal has potential to provide a number of unique benefits that distinguish it from other water storage proposals. The project would serve to preserve the land use patterns and ownership in the upper Big Hole Valley and would provide supplemental irrigation water to area irrigators. The project may provide long-term protection of spawning and rearing habitat for the last riverine native arctic grayling population in the contiguous forty-eight states, and may provide similar benefits for local populations of native westslope cutthroat trout. Finally, the project would provide additional recreational opportunities to users of public lands in the upper Big Hole River Valley.

CHERRY CREEK RESERVOIR STUDY

The proposed project site is located approximately 3 miles northeast of the town of Terry, in the Cherry Creek drainage. Terry is located on the Yellowstone River, midway between the cities of Miles City and Glendive.

Background

BLM conceived the idea of constructing a reservoir on the Cherry Creek drainage as part of its commitment to improve access to recreational opportunities on public lands. BLM committed $150,000 to study the feasibility of the project in 1989, and the state legislature appropriated another $100,000 that was matched with $50,000 from "Friends for Cherry Creek Dam, Inc." of the City of Terry. A partnership was established among the "Friends," DFWP, and BLM. BLM contracted with Reclamation to provide technical data, including cost estimates, hydrology and reservoir operation studies, flood hazard determinations, geologic reports, surveying and mapping, and analyses for supplemental water from the Yellowstone River. Four possible sites were identified and the 50-foot pool depth option was selected.

Current Status

In March 1995, BLM notified the "Friends" that all work would cease in the absence of funding to prepare the required environmental impact statement. Cost estimates have been completed by Reclamation for construction of the earth-filled dam embankment, a gated outlet works, a service spillway, an auxiliary spillway, project design, and construction-related expenses. The 50-foot reservoir would have an estimated life of 136 years and would cost $13.5 million.

Summary

Cost-benefit analyses over the life of the project indicate that the 50-foot pool depth option may have positive returns on investment while accomplishing all three project objectives. While the project is reported to be technically feasible, prospects for obtaining funding for continuation of the project appear unlikely.

V. SEEPAGE MONITORING FOR HIGH-HAZARD DAMS

Seepage monitoring is being considered for all state-regulated high-hazard dams, most of which are earth-filled. Earth-filled dams are designed to allow the passage, or seepage, of limited amounts of water through their fill materials. By carefully monitoring seepage through dams, problems can often be identified prior to the development of an emergency situation. Seepage monitoring plans will eventually be considered for all high hazard earthen dams, regardless of whether indications of seepage are present. In fact, it is uncommon for a large dam located above significant downstream population to not have seepage monitoring instrumentation.

DNRC is planning to evaluate five state-owned dams over the next two years: Cataract Creek Dam (Madison County), Willow Creek Dam (Madison County), Ruby Dam (Madison County), Nevada Creek Dam (Powell County) and Nilan Dams (Lewis and Clark County).

The state has recommended a three-phase program, to ensure that all issues are addressed and the most cost-effective approach is taken at each storage project:

Phase I - Currently underway, this phase begins with an intensive field inventory of all dam seepage. In some instances, shallow hand-driven monitoring wells will be installed. Existing data is being carefully reviewed, and recommendations for further data collection and analysis will be made. Cost estimates to implement recommendations will also be determined during this phase. The results of this phase will be published in a report for review and comment.

Phase II - Consists of implementing the recommendations made during the Phase I portion of the investigation. If drilling is necessary, it will be completed during this phase. The water users would be responsible for hiring a driller. DNRC would technical assistance on a case-specific basis.

Phase III - will consist of developing methods and procedures to collect and analyze the data on a frequent, long-term basis.

Public safety is not the only justification for implementation of a dam seepage monitoring program. In the event of dam-related litigation, monitoring records provide critical evidence demonstrating that a dam was operated and maintained in a conscientious manner. Finally, maintaining a dam seepage monitoring program demonstrates that a certain "standard of care" is exercised by dam owners and regulators on behalf of the public.